REMARKS/ARGUMENTS

Claims 1, 3-7 and 10-23 are currently pending in the present application, of which claims 1 and 23 are independent claims. Claims 9-10 have been canceled without prejudice or disclaimer by this Amendment. Claims 2 and 8 were previously canceled. Claims 1 and 23 have been amended by this Amendment.

Claim Rejections under 35 USC § 103

Claims 1, 3, 4, 6, 11, 15, 22 and 23 stand rejected under 35 USC § 103(a) as unpatentable over U.S. Pub. No. 2004/0004223 ("Nagahama") in view of U.S. Pub. No. 2005/0077538 ("Heikman"). Claims 5, 7, 9, 12-14 and 16 stand rejected under 35 USC § 103(a) as unpatentable over Nagahama and Heikman. Claims 17-20 stand rejected under 35 USC § 103(a) as unpatentable over Nagahama and Heikman in view of U.S. Pat. No. 5,744,828 ("Nozaki"). Claim 21 stands rejected under 35 USC § 103(a) as unpatentable over Nagahama and Heikman in view of U.S. Pat. No. 2003/0111667 ("Schubert").

Discussion of Disclosed Embodiments

The following descriptive details are based on the specification. They are provided only for the convenience of the Examiner as part of the discussion presented herein, and are not intended to argue limitations which are unclaimed.

Applicants' disclosed embodiments are directed to a thin-film LED. (See FIG. 1A of the published version of the present application (US 2007/0278508) showing a cross section of the line I-II from a plan view shown in FIG. 1B). The thin-film LED contains an epitaxial layer sequence 16 comprising an active layer 7. The active layer 7 emits electromagnetic radiation 19

in a main radiation direction 15. The electromagnetic radiation 19 emitted in the main radiation direction 15 by the active layer 7 is coupled out from the thin-film LED through a main area 14. (See paragraph 46 of the published application).

A first contact layer 11, 12, 13 is provided on the main area 14 of the thin-film LED. A current expansion layer 9 containing a first nitride compound semiconductor material, preferably GaN, is contained between the active layer 7 and the first contact layer 11, 12, 13. Embedded in the current expansion layer 9 made of the first nitride compound semiconductor material is at least one layer 10 made of a second nitride compound semiconductor material, preferably made of AlGaN. In other words, the current expansion layer 9 is a multilayer layer comprising for example two GaN partial layers 9a, 9b separated from one another by an embedded AlGaN layer 10. (See paragraph 48 of the published application). The transverse conductivity of the current expansion layer 9 is improved by the semiconductor layer 10 sandwiched in the current expansion layer 9. (See paragraph 49 of the published application).

FIG. 4 schematically illustrates the profile of the dopant concentration δ as a function of a spatial coordinate z, which runs perpendicular to the current expansion layer, that is to say parallel to the main radiating direction. An AlGaN layer is embedded in a current expansion layer made of GaN, both the GaN layer and the AlGaN layer being n-doped in each case. The AlGaN layer has a higher dopant concentration in the regions 24 adjoining the GaN layer than in its inner portion (so-called doping spikes). The number of free electrons which have a high mobility in the potential wells 25 illustrated in FIG. 3B is therefore increased further and the transverse conductivity is consequently improved further. (See paragraph 63 of the published version of the present application).

Arguments

The art cited by the Examiner fails to teach or suggest that "the at least one layer made of the second nitride compound semiconductor material has a doping, a dopant concentration being higher in regions adjoining the current expansion layer than in a central region of the at least one layer made of the second nitride compound semiconductor material" and "the first and second nitride compound semiconductor materials are n-doped", as expressly recited by Applicants' amended independent claim 1 because (1) the Examiner's proffered combination of Nagahama and Heikman at best teaches placing n-doped intermediate layers of Heikman <u>only at every second interface</u> of a layer stack and (2) the skilled artisan would not, in the first place, even use Heikman's n-doped intermediate layers in Nakahama's semiconductor device if the first and second nitride compound semiconductor materials thereof were to be n-doped as suggested by the Examiner because Heikman teaches placing its n-doped intermediate layers at every second interface of <u>an undoped structure</u> for compensating polarization charges which are present at these interfaces.

The Examiner (at pages 7-8 of the Office Action) acknowledges that Nagahama fails to teach that "the at least one layer made of the second nitride compound semiconductor material has a doping, a dopant concentration being higher in regions adjoining the current expansion layer than in a central region of the at least one layer made of the second nitride compound semiconductor material", as expressly recited by Applicants' independent claim 1. The Examiner instead relies on Heikman for these features.

Heikman discloses an AlGaN/GaN heterostructure with alternating GaN layers (L0, L2, L4) and AlGaN layers (L1, L3, L5). (See Fig. 1 of Heikman). Heikman discloses in paragraph 28 the placement of n-type doping only <u>at each even numbered GaN/AlGaN interface</u> (I2, I4,

etc.), and that the doping is equal in magnitude to the negative polarization charge present at the respective interfaces. The n-type doping is placed only at every second interface because, when ionized, the doping serves to compensate for the polarization charge which is present at the interfaces where a GaN layer follows an AlGaN layer in the growth direction due to a polarization of the semiconductor material. The n-type doping at the even numbered GaN/AlGaN interfaces thus eliminates band-curvature at the interfaces. (See paragraphs 7 and 28 of Heikman). However, there is no doping at the odd numbered interfaces (I1, I3, I5) where an AlGaN layer follows a GaN layer in the growth direction of Heikman. Indeed, Fig. 6 of Heikman shows Si doping at the I2 interface and no Si doping at the I1 and I3 interfaces. Even assuming, *arguendo*, the propriety of the Examiner's proffered combination of Nagahama and Heikman (which Applicants do not concede), such a combination at best teaches placing the n-type doped intermediate layers of Heikman only at every second interface of a layer stack.

In contrast, Applicants' amended claim 1 recites that "the at least one layer made of the second nitride compound semiconductor material has a doping, a dopant concentration being higher ***in regions adjoining the current expansion layer than in a central region*** of the at least one layer made of the second nitride compound semiconductor material." Because the second nitride layer is sandwiched in the current expansion layer, both of the interfaces of the second nitride layer adjoin the current expansion layer and are therefore regions that have a higher dopant concentration than the central region of the layer. For example, see Fig. 4 of the present application.

The Examiner's proffered combination of Nagahama and Heikman at best provides for placement of n-type doping at only one interface of a second layer of layer 5 of Nagahama, which the Examiner asserts corresponds to Applicants' claimed at least one layer made of a

second nitride compound material, because Heikman teaches placement of the n-type doping to compensate for the polarization charge which is present only at the interfaces where a GaN layer follows an AlGaN layer. Nagahama and Heikman, whether considered alone or in combination, thus fail to disclose, teach or suggest that "the at least one layer made of the second nitride compound semiconductor material has a doping, a dopant concentration being higher ***in regions adjoining the current expansion layer than in a central region*** of the at least one layer made of the second nitride compound semiconductor material", as expressly recited by independent claim 1.

Furthermore, amended independent claim 1 now recites that "the first and second nitride compound semiconductor materials are n-doped." Heikman, however, discloses only an <u>undoped</u> AlGaN/GaN heterostructure ("in the absence of intentional n-type doping in the structure", see paragraph 24 of Heikman), and only an intermediate layer at every second interface (the gradient layer, as shown in Figs. 4 and 6 of Heikman) is doped.

The Examiner (at page 9 of the Office Action) acknowledges that Nagahama fails to disclose that the first and second nitride compound semiconductor materials are n-doped. The Examiner instead asserts that it would have been an obvious matter of design choice to have the first and second nitride compound semiconductor materials n-doped, "since the device can perform equally well with all the doping changing their polarity, which is well known in the field of semiconductor manufacturing."

However, the Examiner's proffered combination of Nagahama and Heikman requires the placement of Heikman's n-doped intermediate layers between layers of Nagahama's semiconductor device. The skilled artisan would not, in the first place, even use Heikman's n-doped intermediate layers in Nakahama's semiconductor device if the first and second nitride

compound semiconductor materials thereof were to be n-doped as suggested by the Examiner because Heikman teaches placing its n-doped intermediate layers at every second interface of an undoped structure for compensating polarization charges which are present at these interfaces. Accordingly, Heikman provides the skilled artisan no reason to modify the semiconductor device of Nagahama to include first and second nitride compound semiconductor materials that are n-doped. The skilled artisan therefore would not look to combine a semiconductor device such as that disclosed by Nagahama and having first and second nitride compound semiconductor materials that are n-doped as suggested by the Examiner with the n-doped intermediate layers of Heikman because discloses that its n-doped intermediate layers are used in an undoped structure.

The other cited references, Nozaki and Schubert, were cited by the Examiner as purportedly disclosing the features of various dependent claims. However, nothing has been found in Nozaki and Schubert that would remedy the deficiencies of Nagahama and Heikman with respect to the features of claim 1 discussed above.

The prior art cited by the Examiner thus fails to disclose, teach or suggest that "the at least one layer made of the second nitride compound semiconductor material has a doping, a dopant concentration being higher in regions adjoining the current expansion layer than in a central region of the at least one layer made of the second nitride compound semiconductor material" and "the first and second nitride compound semiconductor materials are n-doped", as expressly recited by Applicants' amended independent claim 1.

Accordingly, independent claim 1 is deemed to be patentable over the cited art.

Independent claim 23, as amended, recites features similar to claim 1 and is therefore also deemed to be patentable over the applied prior art for reasons discussed above with respect to claim 1.

Claims 3-7 and 10-22, which each depend from independent claim 1, distinguish the invention over the applied prior art for reasons discussed above in regard to independent claim 1, as well as on their own merits.

Withdrawal of the rejection under 35 USC § 103 is therefore requested.

CONCLUSION

In view of the foregoing, reconsideration and withdrawal of all rejections, and allowance of all pending claims is respectfully solicited.

It is believed that no fees or charges are required at this time in connection with the present application. However, if any fees or charges are required at this time, they may be charged to our Patent and Trademark Office Deposit Account No. 503111.

Respectfully submitted,
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